PROPULSION DIRECTORATE SAVES AIR FORCE $10 MILLION

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Payoff

Based on new solid rocket motor acceptance criteria provided by the Air Force Research Laboratory to the Titan Systems Program Office (SPO), a rocket motor with defects was accepted for operational use. The motor launched a National Reconnaissance Office payload successfully resulting in a $10 million savings to the Air Force.

Accomplishment

In response to a request from the Titan SPO of the Space and Missiles System Center, a team that included personnel from the Propulsion Directorate, the Naval Air Warfare Center, Raytheon Company, SPARTA Corporation and the Aerospace Corporation, developed the first solid rocket motor acceptance criteria based on numerical and experimental fracture mechanics analysis. Using this new acceptance criteria, a TITAN IV rocket motor was accepted and used to successfully launch a National Reconnaissance Office payload into orbit on 7 May 1998.

Background

The overall objective of the support provided to the Titan SPO was to develop a fracture data base to facilitate decision making. The effort consisted of two phases. The objectives of the first phase were to determine the effects of pressure, applied strain level, strain rate, and surface crack size on crack growth behavior in Titan IV solid propellant. The objectives of the second phase were to determine fracture toughness for the onset of crack growth, develop a crack growth model for a given strain rate, and provide information to establish acceptance criteria. The research team, led by Dr. C.T. Liu of the Propulsion Sciences and Advanced Concepts Division, employed an approach that involved a blend of numerical and experimental studies based on fracture mechanics. In the numerical analysis, a three-dimensional elastic computer program was used to determine the distribution of Mode I stress intensity factor along the front of a surface crack in a tensile specimen subjected to a constant strain rate under 1000 psi confine pressure. In the experimental analysis, tensile specimens with different initial crack lengths and specimen thicknesses and geometries were tested. Based on the results of the numerical and experimental analyses, fracture toughness for the onset of crack growth and a crack growth model were determined and acceptance criteria, based on critical crack size, were developed.